What is claimed is:

CLAIM 1. A method for providing feedback to the operator of a portable coordinate measurement machine (CMM) which measures the position of an object in a selected volume, the CMM including a manually positionable articulated arm having opposed first and second ends, said arm including a plurality of joints, a measurement probe attached to a first end of said articulated arm and an electronic circuit which receives the position signals from transducers in said arm and which provides a digital coordinate corresponding to the position of the probe in a selected volume, comprising:

sensing deformation of a portion of said articulated arm when said arm is placed under a load, said deformation being an indication of the magnitude of the external force being applied to such arm; and

providing feedback to the operator of the CMM in response to said sensed external forces.

CLAIM 2. The method of claim 1 wherein said feedback comprises sensory feedback.

CLAIM 3. The method of claim 2 wherein said sensory feedback comprises at least one of auditory and visual feedback.

CLAIM 4. The method of claim 1 wherein said feedback is indicated by software controlling the CMM.

CLAIM 5. The method of claim 1 wherein said feedback defines an overload sensor which prevents overstressing of the articulated arm.

CLAIM 6. The method of claim 1 wherein said deformation occurs in bearing structure associated with at least one of said joints.

CLAIM 7. The method of claim 1 wherein said deformation occurs in tubing associated with said articulated arm.

CLAIM 8. The method of claim 1 wherein said at least one joint includes a periodic pattern of a measurable characteristic, at least two read heads spaced from and in communication with said pattern, said pattern and said at least two read heads being positioned within said joint so as to be rotatable with respect to each other, and including:

using said at least two read heads to sense deformation of the articulated arm.

CLAIM 9. The method of claim 8 wherein said two read heads are positioned 180 degrees apart.

CLAIM 10. The method of claim 8 wherein:

said pattern comprises an optical fringe pattern; and

said at least one read head comprises an optical read head.

CLAIM 11. The method of claim 10 wherein:

said optical fringe pattern is disposed on an optical encoder disk.

CLAIM 12. The method of claim 11 wherein said communication comprises:

said read head detecting the interference between diffraction orders to produce sinusoidal signals from said read head inserted in said fringe pattern, said sinusoidal signals being electronically interpolated to detect displacement.

CLAIM 13. The method of claim 8 wherein said at least two read heads cause cancellation effects that can be averaged.

CLAIM 14. The method of claim 8 wherein:

said pattern of a measurable characteristic is at least one of the characteristics selected from the group consisting of reflectivity, opacity, magnetic field, capacitance, inductance and surface roughness.

CLAIM 15. The method of claim 1 wherein said joints comprise long joints for swiveling motion and short joints for hinged motion.

CLAIM 16. The method of claim 15 including three joint pairs, each joint pair comprising a long joint and a short joint.

CLAIM 17. The method of claim 1 wherein said joints are arranged in the joint configurations selected from the group consisting of 2-2-2, 2-1-2, 2-2-3, and 2-1-3.

CLAIM 18. The method of claim 8 wherein:

said pattern is rotatable with respect to said at least two read heads; and

said two read heads are stationary with respect to said pattern.

CLAIM 19. The method of claim 8 wherein:

said pattern is stationary with respect to said at least two read heads; and

said at least two reads heads are rotatable with respect to said pattern.

CLAIM 20. The method of claim 8 wherein said joint further comprises:

a first and second housing, and a rotatable shaft extending from said second housing into said first housing;

a bearing disposed between said shaft and said first housing permitting said rotatable shaft to rotate within said first housing;

said pattern being attached to said rotatable shaft;

said at least two read heads being fixed within said first housing such that rotation of the first housing with respect to the second housing causes said at least two read heads to move relative to said pattern.

CLAIM 21. The method of claim 8 wherein said at least one joint comprises:

a first housing;

a second housing;

a rotatable shaft fixed to said second housing and extending into said first housing;

at least one bearing supported within said first housing and supporting said rotatable shaft for rotation about its axis; wherein one of said pattern and said at least two read heads are fixed to an end of said shaft and the other of said pattern and said at least two read heads are fixed within said first housing.

CLAIM 22. The method of claim 1 wherein said at least one joint includes a periodic pattern of a measurable characteristic, at least one read head spaced from and in communication with said pattern, said pattern and said read head being positioned within said joint so as to be rotatable with respect to each other, and at least one sensor which measures relative movement in said periodic pattern with respect to said at least one read head and including:

using said at least one sensor to sense deformation of the articulated arm.

CLAIM 23. The method of claim 22 wherein said at least one sensor comprises a plurality of spaced sensors which measure displacement.

CLAIM 24. The method of claim 22 wherein said at least one sensor comprises a sensor which measures displacement.

CLAIM 25. The method of claim 24 including at least one sensor for measuring X-axis displacement of said pattern.

CLAIM 26. The method of claim 24 including at least one sensor for measuring Y-axis displacement of said pattern.

CLAIM 27. The method of claim 25 including at least one sensor for measuring Y-axis displacement of said pattern.

CLAIM 28 The method of claim 22 wherein said at least one joint includes a shaft surrounded, at least in part, by a housing, said shaft and said housing being adapted to rotate relative to one another, and wherein said at least one sensor includes at least one sensor for measuring relative movement between said shaft and said housing.

CLAIM 29. The method of claim 28 including a plurality of sensors for measuring relative movement between said shaft and said housing.

CLAIM 30. The method of claim 28 wherein said shaft is rotatable.

CLAIM 31. The method of claim 29 wherein said shaft is rotatable.

CLAIM 32. The method of claim 31 wherein said at least one sensor includes:

at least two sensors for measuring relative movement of said shaft including a first sensor for measuring X axis displacement and a second sensor for measuring Y axis displacement

CLAIM 33. The CMM of claim 32 wherein said plurality of sensors for measuring relative movement of said shaft further include a third sensor for measuring X axis rotation, a fourth sensor for measuring Y axis rotation and a fifth sensor for measuring Z axis displacement.

CLAIM 34. The CMM of claim 32 wherein said at least one read head measures Z axis rotation of said shaft.

CLAIM 35. The CMM of claim 34 wherein said at least one read head measures Z axis rotation of said shaft.

CLAIM 36. The method of claim 36 wherein said third, fourth and fifth sensors are positioned at about 120 degrees with respect to each other.

CLAIM 37. The method of claim 28 including at least five sensors which, together with said read head, measure at least six degrees of freedom of said shaft.

CLAIM 38. The method of claim 22 wherein said at least one sensor includes:

at least two sensors which measure movement in said periodic pattern with respect to said at least one read head.

CLAIM 39. The method of claim 38 wherein:

said at least two sensors are positioned at about 90 degrees to each other.